PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

02/2004

ANALYSIS OF DEVONIAN BLACK SHALE IN KENTUCKY FOR POTENTIAL CARBON DIOXIDE SEQUESTRATION AND ENHANCED NATURAL GAS PRODUCTION

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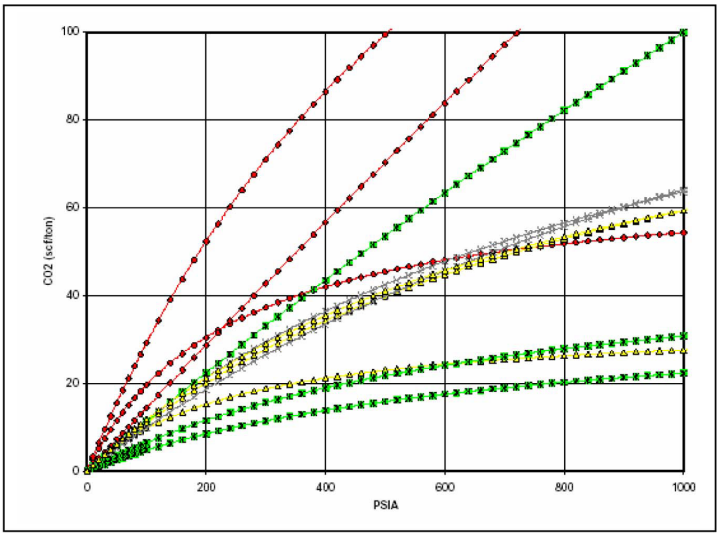
Background

Global climate change is an area of increasing concern, and many scientists believe the cause is due, at least in part, to increased emissions of CO_2, especially from the combustion of fossil fuels. These concerns are driving initiatives to develop carbon management technologies. One promising approach is geologic sequestration of CO_2. Options being investigated include sequestration in saline aquifers, oil and gas reservoirs, and unminable coal seams. In unminable coal seams, CO_2 is injected into the seam and is adsorbed on the surface of the coal, displacing methane that is recovered and sold to help offset sequestration costs. In analogy with sequestration in coal seams, another option may be sequestration in Devonian black shales, organic-rich rocks that serve as both a source and trap for natural gas. Most of the natural gas is adsorbed on clay or kerogen surfaces, very similar to the way methane is stored within coal beds. It has been demonstrated in gassy coals that, on average, CO_2 is preferentially adsorbed, displacing methane at a ratio of about one molecule of methane for two molecules of CO_2. Black shales may similarly desorb methane in the presence of adsorbing CO_2. If this is the case, the black shales of Kentucky could be a viable geologic sink for CO_2, and their extensive occurrence in Paleozoic basins across North America would make them an attractive regional target for economic CO_2 storage and enhanced natural gas production.



Absorption Isotherms of Devonian Black Shales. Several samples exhibit unexpectedly high measureed values for the adxorbed volume of CO_2

CUSTOMER SERVICE

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WEBSITE

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PARTNERS

University of Kentucky Research Foundation and Kentucky Geological Survey

COST

Total Project Value:
$532,966

DOE/Non-DOE Share:
$364,453 / $168,513

Primary Project Goal

To test the hypothesis that organic-rich shales can adsorb significant amounts of CO_2 while releasing methane. This will be accomplished by examining core samples of Devonian shales for CO_2 adsorption capacity and developing a technique for estimating the CO_2 sequestration potential of shales in Kentucky.

Objectives

- To characterize the petrology, total organic content, and elemental composition of selected shale samples, and to correlate these properties with CO_2 adsorption capacity.
- To determine CO_2 adsorption isotherms of these samples.
- To determine the relationship between CO_2 adsorption and CH_4 desorption.
- To locate zones within shale deposits that have high CO_2 adsorption capacities.
- To delineate the vertical and aerial extent of these zones.

Accomplishments

A literature search has been completed, and a bibliography of articles and papers pertinent to shales has been prepared. Selected shale samples have been analyzed and characterized. A preliminary estimate has been prepared of the potential for CO_2 sequestration in the shales of Kentucky.

Drill cuttings and cores were selected from the Kentucky Geological Survey Well Sample and Core Library, and methane and CO_2 adsorption analyses are being performed to determine the gas storage potential of these shales and to identify shale facies with the most sequestration potential. In addition, sidewall core samples are being acquired to investigate specific black-shale facies, their potential CO_2 uptake, and the resulting displacement of methane. Advanced logging techniques (elemental capture spectroscopy) are being investigated for possible correlations between adsorption capacity and geophysical log measurements.

Measured adsorption isotherm data range from 37.5 to 2,077 scf/ton of shale. At 500 psia, adsorption capacity of the Lower Huron Member of the shale is 72 scf/ton. Initial estimates indicate a sequestration capacity of 5.3 billion tons of CO_2 in the Lower Huron Member of the Ohio shale in parts of Eastern Kentucky and as much as 28 billion tons total in the deeper and thicker portions of the Devonian shales in Kentucy.

Benefits

To meet the President's goal of decreasing CO_2 emissions per dollar of GDP by 18% by 2012, it will probably be necessary to sequester CO_2 in geologic and terrestrial sinks. Having a range of viable options for CO_2 sequestration increases the likelihood of successfully meeting the President's goal. This project will evaluate an option that has received relatively little attention—storing CO_2 in shale deposits, while simultaneously producing natural gas, the sale of which can help offset sequestration costs. The potential capacity of shales to sequester CO_2 is very large, and being able to store CO_2 in shales could significantly increase the life of fossil fuel based power plants, if reductions in anthropogenic greenhouse gas emissions are required.